

Application Serial No. 10/051,494
Docket No.: SC114492K

REMARKS:

Prior to addressing the specific rejections made by the Examiner, the following overview of the present invention, and of how the present invention differs from the prior art, may be useful.

As noted at Page 4, Lines 20-23 of the present application, Applicants have discovered that a high quality, low defect dielectric layer structure can be created on a GaAs substrate through a two-step process. In the first step, a layer of gallium oxide is deposited on the GaAs substrate to form a gallium oxide/GaAs interface. This may be achieved through thermal evaporation of crystalline Ga₂O₃ or through evaporation of a high purity single crystalline source. See, e.g., Page 5, Lines 14-19. Notably, both of these methods produce a layer of pure gallium oxide that is devoid of any Gd. In the second step, a layer of Ga-Gd-oxide is then deposited over the layer of pure gallium oxide. See, e.g., Page 6, Lines 1-3. As explained at Page 6, Lines 12-17 of the present application, this two-step approach provides a dielectric structure that has both a low defect density at the oxide-GaAs interface and a low oxide leakage current.

In contrast to the presently claimed invention, prior art processes for forming dielectric layers in compound semiconductor structures are typically single step processes involving the formation of either a gallium oxide/GaAs interface, or a Ga-Gd oxide/GaAs interface. Hong et al., which has been cited by the Examiner in all of the rejections set forth in the present office action, is exemplary of the later type of process. In particular, in Hong et al., Ga-Gd-oxide is deposited in a single step on a GaAs substrate. The deposition occurs in such a way that there is a gradient in the concentration of Gd throughout the dielectric layer, with the concentration of Gd being

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lowest at the dielectric/GaAs interface and highest at the exposed surface of the dielectric layer.

The rejections set forth by the Examiner will now be considered in light of these differences between the present invention and the cited art.

Reconsideration of the Examiner's rejection of claims 9-11, 14, 15, and 18-22 under 35 U.S.C. § 102(b) as being anticipated by Hong et al. is respectfully requested.

The Examiner is respectfully reminded that, in order to anticipate a claimed invention, a cited reference must clearly disclose each and every element of the claimed invention. In the present case, however, Hong et al. does not disclose the claimed elements of "depositing a first layer of gallium oxide on a surface of the supporting structure" and "depositing a second layer of a Ga-Gd-oxide on the first layer" as required by claim 9 and the claims dependent thereon. Rather, as noted above, Hong et al. discloses a one-step process whereby a layer of Ga-Gd-oxide is deposited over a substrate.

While the cited portion of Hong et al. (Col. 2, Lines 61-63) does note that the concentration of Gd in the Ga-Gd-oxide layer varies throughout the thickness of the layer such that "at least at the semiconductor/dielectric interface the dielectric material consists essentially of Ga_2O_3 ", the Examiner is respectfully reminded that, in

considering a reference, the Examiner may not pick and choose among the teachings of a reference, taking only those teachings which support a given position while ignoring others that teach away from it. Rather, the reference must be construed as a whole for what it fairly suggests to one skilled in the art.

In the present case, when Hong et al. is construed as a whole for what it fairly suggests to one skilled in the art, it is clear that the statement of Hong et al. which is cited

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by th Examiner does not mean that there is no Gd at the interface, but rather that the concentration of Gd at the interface is small compared to the concentration elsewhere in the layer. Thus, the reference notes, at Col. 10, Lines 21-31, that

Analysis of GaAs/Ga₂O₃ structures according to the invention that comprise a dielectric layer deposited as described above (i.e., using a Gd₃Ga₅O₁₂ source) has revealed the presence of a significant amount of Gd in the dielectric layer. The Gd concentration is typically highest at or near the surface of the dielectric layer, but is substantially (e.g., by up to three orders of magnitude) less close to the semiconductor/dielectric interface.¹

It is also to be noted here that, since Hong et al. does not explicitly disclose the step of depositing a first layer of gallium oxide on a surface of the supporting structure, the Examiner is necessarily relying on an inherency theory in positing the existence of such a step in the method of Hong et al. (that is, the Examiner is inferring the existence of such a step in the methodology of Hong et al. based on the description of the structure of the device disclosed therein). However, as noted in M.P.E.P. § 2112, for the purposes of establishing inherency, the disclosure of an element of a claimed invention may not be a matter of mere possibilities or even probabilities. Rather, the cited reference, when construed as a whole, must make clear that the element is necessarily present in the thing described in the reference:

The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. ... "To establish

¹ Of course, it is notable here that even small concentrations of Gd at the interface can have a significant effect on the electrical properties of a device. It is thus unlikely that two otherwise identical devices made in accordance with the present invention and in accordance with the methodology of Hong et al. would have similar electrical properties.

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inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.'"

In the present case, when Hong et al. is construed as a whole for what it fairly suggests to one skilled in the art, it is clear that the concentration of Gd at the interface is not actually known. Indeed, this fact is acknowledged by Hong et al. at Col. 10, Lines 28-31, where the reference states that

Due to experimental limitations the dielectric composition directly at the interface has not been determined, but is expected to be essentially pure Ga₂O₃, with at most about 100 ppm of Gd. [emphasis added]

Since the concentration of Gd at the interface of the device of Hong et al. is not actually known, it follows that there is no way of knowing whether the step of depositing a layer of gallium oxide actually occurs in the process of Hong et al. prior to the step of depositing Ga-Gd-oxide. Since such a step is not necessarily present in the method of Hong et al., but is at best only possibly present, such a step cannot be said to be inherent in the teachings of Hong et al. Hence, Hong et al. does not anticipate the claimed invention.

Reconsideration of the Examiner's rejection of claims 12, 13, 16, 17, 23 and 24 under 35 U.S.C. § 103(a) as being unpatentable over U.S. 5,962,883 (Hong et al.) in view of the Examiner's official notice (that provision of oxygen by evaporation in evaporation processes was known prior to Applicants' invention) is respectfully requested.

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In order to render a claimed invention obvious, a proposed combination of references must teach or suggest each and every element of the claimed invention. In the present case, however, as noted above with respect to the novelty rejection, Hong et al. does not disclose the elements of "depositing a first layer of gallium oxide on a surface of the supporting structure" and "depositing a second layer of a Ga-Gd-oxide on the first layer". The official notice of the Examiner does not address this deficiency, and hence does not remedy it.

Moreover, even if, as the Examiner asserts, it was known to the prior art to provide oxygen by evaporation in evaporation processes, the Examiner is respectfully reminded that the prior art must teach the desirability of providing oxygen by evaporation in the manner specified by the claims.

This fact is recognized by MPEP 2143.01, which deals with motivation to combine. Notably, the subtitle of this section is "THE PRIOR ART MUST SUGGEST THE DESIRABILITY OF THE CLAIMED INVENTION". [emphasis added] That same section of the MPEP states that

"The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination." [emphasis added]

In the present case, the Examiner has not shown that the suggested combination of Hong et al. with the practice officially noticed by the Examiner is a desirable combination. To the contrary, the Examiner's argument appears to suggest that the proposed combination would be undesirable. Thus, for example, the Examiner argues that

it would have been within the scope of one of ordinary skill in the art to determine a suitable amount of oxygen to add to the process at the beginning of the process with the expectation that provision of oxygen would result in an atomically unclean surface and the disclosed concomitant disadvantages. [emphasis added]

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While it could be argued that other sections of Hong et al. (e.g., Col. 7, Lines 54-61) could possibly be interpreted to teach that oxygen exposure should be limited until sometime after formation of the first monolayer of dielectric material on the surface of the GaAs substrate, such teachings are still insufficient to render the present claims obvious. In particular, while one could argue that Hong et al. teaches that oxygen exposure is permissible after formation of the first monolayer, there is still no teaching or suggestion in Hong et al. that oxygen exposure is desirable at this point in the process, nor does the Examiner's official notice (that oxygen evaporation processes were previously known) suggest the desirability of depositing atomic oxygen at this point in the process. Hence, Hong et al., taken either alone or in combination with the Examiner's official notice, is insufficient to support a prima facie case of obviousness.

For the sake of completeness, Applicant also notes that there is no teaching or suggestion in Hong et al. that deposition of atomic oxygen during deposition of gallium oxide improves the quality of the initial gallium oxide layer by reducing oxygen vacancies that give rise to defects. Absent such a teaching (and in light of the fact that chemistry is an unpredictable art), this finding by the present Applicant must be regarded as an unexpected result that further underscores the unobviousness of the present invention.

Applicants note the following with respect to the new claims added with this response:

With respect to new claims 26-33 which have been added with this response, Applicants note that these claims further distinguish the present invention from the prior art, because they require that the gallium oxide and Ga-Gd-

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oxide come from different sources. There is no teaching or suggestion in Hong et al. to deposit a layer of gallium oxide from a first source, and then deposit a layer of Ga-Gd-oxide from a second source onto the layer of gallium oxide. Claims 29-30, 32 and 33 further distinguish the present invention from the prior art, because they require the deposition of atomic oxygen during deposition of the first layer or immediately after formation of a first monolayer of gallium oxide. As noted with respect to the Examiner's obviousness rejection, there is no teaching or suggestion of this feature of the invention in Hong et al., either taken alone or in combination with the Examiner's official notice, nor is there any teaching of the advantages attendant to this feature.

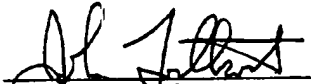
Support for new claims 26-28 and 31 can be found in FIG. 2 and in the accompanying text, especially the portion at Page 6, Line 31 to Page 7, Line 23. Support for claims 29-30, 32 and 33 can be found, for example, at Page 7, Lines 6-13.

Applicants submit that the pending claims are in condition for allowance. An early indication thereof is respectfully solicited. Please charge any fee deficiency due with this amendment, including the additional claims fee of \$90, or credit any overpayment, to Deposit Account No. 50-2583.

Respectfully submitted,

7-1-03
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